ORIGINAL ARTICLE

A randomised controlled trial of patient self management of oral anticoagulation treatment compared with primary care management

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Background: The increase in numbers of patients receiving warfarin treatment has led to the development of alternative models of service delivery for oral anticoagulant monitoring. Patient self management for oral anticoagulation is a model new to the UK. This randomised trial was the first to compare routine primary care management of oral anticoagulation with patient self management.
Aim: To test whether patient self management is as safe, in terms of clinical effectiveness, as primary care management within the UK, as assessed by therapeutic international normalised ratio (INR) control.
Method: Patients receiving warfarin from six general practices who satisfied study entry criteria were eligible to enter the study. Eligible patients were randomised to either intervention (patient self management) or control (routine primary care management) for six months. The intervention comprised two training sessions of one to two hours duration. Patients were allowed to undertake patient self management on successful completion of training. INR testing was undertaken using a Coaguchek device and regular internal/external quality control tests were performed. Patients were advised to perform INR tests every two weeks, or weekly if a dose adjustment was made. Dosage adjustment was undertaken using a simple dosing algorithm.
Results: Seventy eight of 206 (38%) patients were eligible for inclusion and, of these, 35 (45%) declined involvement or withdrew from the study. Altogether, 23 intervention and 26 control patients entered the study. There were no significant differences in INR control (per cent time in range: intervention, 74%; control, 77%). There were no serious adverse events in the intervention group, with one fatal retroperitoneal haemorrhage in the control group. Costs of patient self management were significantly greater than for routine care (£90 v £425/patient/year).
Conclusion: These are the first UK data to demonstrate that patient self management is as safe as primary care management for a selected population. Further studies are needed to elucidate whether this model of care is suitable for a larger population.

T he expansion of clinical indications for warfarin,[1][2] particularly stroke prevention in non-rheumatic atrial fibrillation,[3][4] has heightened concerns over where and how warfarin monitoring should be undertaken.[5][6] This is an important policy issue for all healthcare systems because current data show that only one third of patients with identified atrial fibrillation over the age of 65 are currently receiving anticoagulation.[7]

Current models of oral anticoagulation management within the UK include the traditional hospital outpatient model and various forms of community management, all of which require patient attendance at a clinic of some sort. We have previously demonstrated the efficacy of primary care oral anticoagulation management using near patient testing to estimate international normalised ratio (INR) and computerised decision support software for dosage supervision within a practice nurse led clinic (the Birmingham model).[8]

> "Studies from Europe and the USA have suggested that patient self management can improve therapeutic control compared with routine testing"

An alternative model of care involves patients measuring their own INR using near patient testing equipment and interpreting the result themselves, in a similar way to diabetic patients monitoring their own glucose control. This model is widespread in Germany and is known as patient self

management.[9] Although convenience and patient autonomy are undoubtedly an important feature of this model, the relative clinical effectiveness of patient self management must be established before recommendations can be made regarding its wider implementation. Reliable portable machines are available, which have been subjected to rigorous laboratory evaluation.[10–12] Studies from Europe and the USA have suggested that patient self management can improve therapeutic control compared with routine testing.[13–19] However, the routine care comparitor within these studies often represents suboptimal performance.[20] Furthermore, the cost implications of patient self management for the UK National Health Service system are not directly equivalent to the costs for private health insurance schemes in other countries.

We report the first data from a randomised controlled trial to investigate the efficacy of patient self management compared with optimal routine management within the UK.[21] Outcome measures included INR control in terms of the percentage of time spent within the therapeutic range and the proportion of tests within the therapeutic range, serious adverse events, and costs. Our study also investigated the criteria for the selection of patients for patient self management,

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Abbreviations: CRF, clinical report form; EQA, external quality assurance; INR, international normalised ratio; IQC, internal quality control

patient attitude towards patient self management, and quality of life issues.

METHODS

Six general practices in the West Midlands using the Birmingham model of anticoagulation management were recruited for our study. Before the original near patient testing and computerised decision support software trial, those practices had not been involved in anticoagulation monitoring and were typical of service practice. Clinics were nurse led and used a Coaguchek near patient testing device (Roche Diagnostics Lewes, Sussex, UK) for INR measurement and computerised decision support software (BAP-PC; University of Birmingham) for the interpretation of the results.

All patients attending the clinic, over the age of 18, receiving long term anticoagulation treatment for a period of at least six months, with sufficient vision and manual dexterity to operate a Coaguchek near patient testing system, and with satisfactory INR control, defined as achieving INR within 0.5 of the target value for at least 60% of the time in the previous 12 months, were identified. From this list, the practice nurse was asked to select patients who would be capable of performing patient self management, following the criteria of previous treatment adherence, physical well being, anxiety, cognitive ability, visual acuity, and ability to follow simple instructions. These selected patients were invited to an informal talk about the study and asked to give written consent. Patients who consented to participate in the study were randomly allocated using computer generated coding into either intervention (patient self management) or control (routine clinic management).

Intervention group (patient self management)

Those in the self management group of patients were required to attend a training course involving two workshops of one to two hours, one week apart. Workshops, based within individual practices, were organised by research staff and attended by practice staff. Sessions covered theoretical and practical aspects of anticoagulation management, including the procedure for performing a blood test using the near patient testing device, quality control procedures, and managing the INR result using a specified algorithm (fig 1).

After the first training session, patients were given a near patient testing device and test strips to practice blood tests at home. They were asked to record at least six results and highlight any problems. At the second session they were given a series of clinical vignettes to assess their understanding of INR management. Patients were individually assessed by the research team and if it was felt that they were competent to carry out self management, sufficient test strips and quality control vials were provided for home use.

For a six month period, patients were required to perform an INR test every two weeks or after one week following dosage adjustment. Batch numbers and expiry dates of test strips and quality control vials distributed to patients were recorded centrally. Daytime access to medical advice was provided via a pager and patients were instructed that the dosing algorithm could be overridden only after consultation with the research team. Support was also available from their practice nurse and general practitioner, and a record kept describing all contacts made by the patients. Self management patients were provided with a clinical report form (CRF) to record INR results, warfarin dose, adverse events, advice received, and number of test strips used.

Internal quality control (IQC) was provided by the manufacturer and performed at week 1, week 8, and week 20 of the study. Patients were also asked to perform IQC if they recorded an unusual INR result or when using a new batch of test strips. External quality control (EQC) was performed four times during the study period, twice at home without

A

INR result	Warfarin dose	Next test due
<1.1		Contact nurse
1.1–1.9	Increase by ...mg	1 week
2–3	Same dose	2 weeks
3.1–3.9	Decrease by ...mg	1 week
>4		Contact nurse

B

Current warfarin dose	Change of dose
1–2 mg	↑/↓ 0.5 mg
3–6 mg	↑/↓ 1.0 mg
6–9 mg	↑/↓ 1.5 mg
9 mg or over	↑/↓ 2.0 mg

Figure 1 Patient algorithm.

supervision (weeks 10 and 20) and twice at the practice with supervision by research personnel (weeks 12 and 22). EQC was provided by the National External Quality Assessment Scheme in the form of lyophilised plasma samples and diluents. Two separate lyophilised samples were used and one sample was tested on three occasions. Patients performed EQC tests on the Coaguchek provided, and were given a performance grading based on the consensus result from other users of the same near patient testing device. This included all sites nationally, either within or remote from a laboratory setting.

Control group

Control patients were managed as before in routine practice clinics using the Coaguchek near patient testing device for INR measurement. Practice nurses entered data on INR, warfarin dose, number of test strips used, and any adverse events on to the CRF at each visit.

Collection of patients' responses to self management

At study conclusion, a random sample of patients (eight patient self management and eight control) were given a semistructured interview covering relevant themes generated from a series of focus groups, which involved professionals involved in anticoagulation management. Material was pooled to elicit questions relevant to their experience in the study—for example, the training, alternative methods of care, attitudes to self management, and self efficacy. Questions from a previously validated questionnaire[22] regarding warfarin treatment were also used, in addition to the SEIQoL tool for quality of life estimation.[23] Interviews were audiotaped and transcribed. Content analysis of the questionnaires was used to draw out common themes and valid comment.

Table 1 Resource items and unit costs

Resource item	Unit cost (£)	Source
Control group		
Follow up attendance at anticoagulation clinic	8.84	Parry et al[24]
Intervention group		
Test strip (for each strip)	2.30	Manufacturer
Advice by practice nurse (for each 15 minute consultation)	5.75	Netten[25]
Internal quality control (for each assessment)	2.30	Manufacturer
External quality control (for each assessment)	30.00	NEQAS
Training session (for each patient)*		
Room hire	6.00	Parry et al[24]
Staff time	20.00	Parry et al[24]
Test strips	23.00	Manufacturer
Quality control	1.46	Manufacturer
Equipment (per machine)	400.00r	Manufacturer

*Assuming 5 patients for each training session.
NEQAS, National External Quality Assessment Scheme.

Data analysis

Data were collated on to an SPSS database for analysis. Townsend scores of home addresses were compared. Individual statistical tests included McNemar's test for dependent proportions, χ^2, and log linear modelling.

Cost data were collected over the six month follow up period on a per patient basis, allowing the estimation of health service costs for each study patient. The data focused on key resource use items where variation by trial arm was hypothesised a priori. These items, along with the unit costs used in this analysis, are listed in table 1. The mean cost each year for each group (control versus intervention) was compared using standard parametric methods (t test), given that the cost distributions were not highly skewed.

RESULTS

Two hundred and six of a total of 298 (70%) patients attending the anticoagulation clinics at six study practices fulfilled preliminary requirements for study entry. One hundred and twenty eight of 206 (62%) were considered inappropriate for patient self management by practice nurses, and 22 of 78 (28%) of the remaining patients refused to enter the study. Reasons for exclusion included; problems with manual dexterity (13%), anxiety (12%), lack of cognitive ability (8%), non-compliance (6%), physically unwell (8%), or too elderly for patient self management (12%). Fifty six of 206 (27%) patients entered the study (26 controls, 30 patient self management). Seven patients randomised to patient self management were not included for analysis: three did not attend the training sessions, one failed the assessment, and three dropped out within the first month of the study (two because of a loss of confidence and one because of problems with manual dexterity). Therefore, 23 patients randomised to the patient self management group were included in the trial analysis.

There were no significant differences in mean age (patient self management, 63 years; controls, 69 years) or Townsend scores between the two groups. A larger proportion of men than women took part in the study (37 men, 12 women). Twenty one of the 23 participants were white and 17 of 23 were retired.

Clinical indications for warfarin treatment were similar between the two groups, with most patients receiving warfarin for atrial fibrillation (27 of 49).

INR control and adverse events

There was no significant difference in prestudy (six months) INR percentage time in range (66% patient self management versus 76% controls). There were no significant differences between the two groups in the percentage time in range (74% patient self management versus 77% controls) or the proportion of tests in range (66% patient self management versus 72% controls) for the study period (table 2), and no significant change between prestudy and study data for either group.

There were seven self reported minor adverse events (two breathlessness, two unexplained bruising, one haematuria, and one menorrhagia) and no serious events in the intervention group. There was one serious adverse event in the control group, a fatal retroperitoneal haemorrhage. There were no recorded minor adverse events in the control group. Control patient data were abstracted from clinical records, whereas intervention patients were asked directly at follow up regarding adverse events. The need for telephone support was minimal.

External quality assurance

The EQA results from the study participants were compared with the results from 75 health care professionals using the Coaguchek near patient testing device. There were no significant differences in median INRs between the patients and the professionals (table 3).

Frequency of testing and costs

In the six months before the study, there was no significant difference between groups in mean number of tests performed for each patient(6.1 patient self management versus 5.9 controls). The patient self management group showed a significant increase in the mean number of tests for each patient during the study (14.6 patient self management versus 5.3 controls; $p < 0.001$), giving a mean frequency of testing of 1.6 weeks for the patient self management group and five

Table 2 International normalised ratio results

	Percentage time in range (95% CI)	Percentage of tests in range (95% CI)
Self management (n=23)	74 (67–81)	66 (61–71)
Control (n=26)	77 (67–86)	72 (65–80)

CI, confidence interval.

Table 3 National External Quality Assessment Scheme results

	Sample 1 Median INRs	Sample 2 Median INRs
Patients (n=23)	3.6, 3.8, 3.7	2.9
Professionals (n=75)	3.4	2.8

INR, international normalised ratio.

Table 4 Total cost for each patient calculated for each year

	Intervention group	Control group
Number	23	26
Mean	425.23*	89.71*
SD	52.65	38.58
Median	413.53	88.40
Interquartile range	388.23–459.53	53.04–123.76
Range	342.23–563.03	17.68–141.44

*p<0.001, t test.

weeks for the control group. Sixty one of 336 (18%) of INR tests performed by the patients in the self management group during the study period were outside protocol criteria. The reasons given for extra tests were: concurrent antibiotic treatment, tooth extraction, and working abroad.

The mean cost each year for patients in the intervention arm was £425 compared with £90 for patients in the control arm (p < 0.001). Intervention costs were based on capital costs (spread over five years at a rate on interest of 6%) and running costs of the equipment, quality control, training, and support from the practice. Control costs were based on average cost for each patient attending a primary care clinic. These costs included capital costs of equipment, training of the general practitioner and practice nurse (spread over five years at a rate on interest of 6%), running costs to include time spent by practice nurse in running the clinic, general practitioner support, test strips, and service charge for room usage (table 4). Indirect costs to the patient were not included.

Interviews and questionnaires

Five common themes emerged from the patient self management interviews: knowledge and management of condition and self empowerment, increased anxiety and obsession with health, self efficacy, relationship with health professionals, and societal and economic cost. No significant difference in quality of life was found between the two groups.

DISCUSSION

This study aimed to evaluate the clinical effectiveness of patient self management compared with a routine primary care clinic. Patient self management involved near patient testing technology (Coaguchek), which has been shown to be safe in previous studies.[14 17 19 26] Patients managed the near patient testing device with minimal support following the training, and coped with both IQC and EQA procedures.

No difference in INR control or serious adverse events was found between the two groups, demonstrating that selected UK patients are capable of measuring their own INR and dosing their warfarin accordingly. These are important data because a criticism of previous studies is that the standard care comparator was suboptimal,[26–28] whereas INR percentage time in range data for routine care are demonstrably better in our study than previously reported data (77% versus 50%, respectively).[14 29]

Only 38% of patients receiving warfarin were considered suitable for patient self management and nearly one third (28%) of these refused to participate. Furthermore, because about a quarter of those patients randomised to patient self management withdrew from the study overall, just under half of those considered eligible for patient self management consented and completed the study. Therefore, these excellent INR results may reflect that only motivated, compliant, and long term treatment patients were recruited.

Although poor treatment adherence has been cited as a major cause of unstable anticoagulation with warfarin,[30] patient self management has been shown to have a positive influence in the control of diabetes,[31 32] and hypertension.[33]

Therefore, it is possible that instead of aiming patient self management primarily at motivated patients, a package of training, self management, and support may be the solution to encourage motivation in less dedicated patients. The results of our study interviews agreed with previous ones in that poor adherence can be improved with patient self management. For most patients, the reduction in professional support was seen as a positive aspect of their care, as long as support was available. Further studies are needed to elucidate definitions for selection, perhaps based more on patient self selection and the identification of inappropriate patients after training and assessment.

Training was based on the German nationally approved programme for anticoagulation[29] and other centres have described similar training of varying intensity.[20]

The patient self management group in our study performed INR tests almost three times more frequently than the routinely managed group in demonstrating equivalent therapeutic control. The two weekly testing conducted within our study was based on previous studies.[29] At present, there are no formal guidelines relating to the frequency of testing for optimum management and it is an area that also requires further investigation.

> "For most patients, the reduction in professional support was seen as a positive aspect of their care, as long as support was available"

The high cost for patients in the intervention arm is a function of the number of tests undertaken and the consumable and equipment costs of self management tests. If this technology becomes more more widely available and its associated costs fall over time then the costs for patient self management could become more favourable. Test strips are now available on prescription, which would enable more patients to undertake patient self management, although there are obvious cost implications for the National Health Service. However, on current evidence, a more conventional approach to the management of patients receiving anticoagulation is by far the cheapest option.

For our study, patients successfully performed EQA on four separate occasions and these results will contribute to the debate concerning patients' ability to manage EQA.[34] IQC is considered by some to be an adequate performance test for the reliability of the result, but although it is a useful test to assess day to day precision it could be argued that the target range is unacceptably wide. In addition, if EQA is deemed essential for hospital and primary care clinics undertaking INR measurement, the same conditions must apply to patient self management, although this has not been referred to in previous patient self management studies.

In conclusion, patient self management is in an embryonic phase in the UK, and these are the first data to suggest that it is as clinically effective as routine care, in this case primary care management of oral anticoagulation. Evidently patient self management is more costly than practice based management as a result of increased use of the near patient testing device, test strips, quality assurance, and training. Some of these excess costs may not prove necessary. Nevertheless, if patient self management costs are confirmed as higher than routine care they could only be recouped within the National Health Service by reductions in serious adverse events, particularly stroke. Given that routine care in the UK is already good this outcome is unlikely.

Before consideration can be given to widespread adoption of this model further UK research is needed. This will need to deal with issues around the nature of training, the definition of patient eligibility, the frequency of testing, and costs. Although cost effectiveness appears unlikely considering these preliminary data, patient self management has been

Take home messages

- There were no significant differences in the international normalised ratio control between the self management patients and the control group and there were no serious adverse events in the self management group
- Thus, patient self management was as safe as primary care management for this selected population
- However, the costs were significantly higher in the self managemnt group (£90 v £425/patient/year)
- Further studies are needed to elucidate whether this model of care is suitable for a larger population

shown to be safe and effective for the minority of patients who might select it.

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